

COLORADO RIVER RECOVERY PROGRAM
FY 2012 ANNUAL PROJECT REPORT

RECOVERY PROGRAM
PROJECT NUMBER: 138

- I. Project Title: Young-of-the-year Colorado pikeminnow monitoring
- II. Bureau of Reclamation Agreement Number: R09AP40847
Project/Grant Period: Start date: 11/13/2008
End date: 4/30/2015
Reporting period end date: 9/30/2012
Is this the final report? Yes _____ No X

III. Principal Investigator(s):

Joseph A. Skorupski Jr., Matthew J. Breen, and Benjamin P. Kiefer
Utah Division of Wildlife Resources
Northeastern Regional Office
318 North Vernal Ave.
Vernal, UT 84078
Phone: 435-781-5315; Fax: 435-789-8343
E-mail: jskorupski@utah.gov

Katie Creighton
Utah Division of Wildlife Resources
Moab Field Station
1165 S. Highway 191 - Suite 4
Moab, UT 84532
Phone: 435-259-3784; Fax: 435-259-3785
E-mail: katherinecreighton@utah.gov

IV. Abstract:

Monitoring of young-of-year (YOY) Colorado pikeminnow (*Ptychocheilus lucius*) is an ongoing project that was initiated in 1986 within the upper Colorado River basin as part of the Interagency Standardized Monitoring Protocol (ISMP; USFWS 1987). The ISMP sampling was proposed to monitor recruitment success of age-0 endangered fishes. All reaches within the study area have experienced, on average, a 75% decrease in YOY pikeminnow catch rates between 1986 and 1995 and have remained at reduced levels through recent years (Breen et al. 2011). Environmental conditions in 2012 were moderately dry in the Upper Colorado River drainage, which likely influenced age-0 recruitment. In the middle Green River, two pikeminnow were captured which was lower than the 10 year average; however, 293 pikeminnow were captured in the lower Green River, which was higher than the 10 year average.

- V. Study Schedule: It is anticipated that this study will continue indefinitely and will be a component of studies designed to evaluate a variety of management actions.

- VI. Relationship to RIPRAP: Reproduction and recruitment of early life stages are critical components of the life history of endangered Colorado pikeminnow. Understanding trends in reproductive success may help define status of Colorado pikeminnow in specific river reaches in the Colorado River basin and should play a role in determining when recovery has been achieved.

Relationship to specific RIPRAP items:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

- VI. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).
VI.A. Measure and document population and habitat parameters to determine status and biological response to recovery actions.
VI.B.2. Conduct appropriate studies to provide needed life history information.

GREEN RIVER ACTION PLAN: MAINSTEM

- VI. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).
VI.A. Conduct research to acquire life history information and enhance scientific techniques required to complete recovery actions.

COLORADO RIVER ACTION PLAN: MAINSTEM

- VI. Monitor populations and habitat and conduct research to support recovery actions (research, monitoring, and data management).
VI.A. Conduct research to acquire life history information and enhance scientific techniques required to complete recovery actions

- VII. Accomplishment of FY 2012 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings

Project Objectives:

1. Determine size and relative abundance of YOY Colorado pikeminnow at the end of their first growing season to complement larval and juvenile sampling data.
2. Estimate the response of small-bodied and YOY native fish to removal of northern pike and smallmouth bass.
3. Determine relationships between YOY Colorado pikeminnow CPUE abundance estimates with respect to flow and temperature.

Task Description (FY 2012):

1. Middle Green River (reach 4) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
2. Lower Green River (reach 3) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
3. Lower Colorado River (reach 1) – Seine backwaters and low velocity habitats to collect data for endangered, native, and nonnative fish. Collect physical habitat data.
4. Data entry.
5. Data analysis and report preparation.

Accomplishments by task (FY 2012).

Task 1: Middle Green River: Reach 4

Annual monitoring for YOY Colorado pikeminnow began 17 September 2012 and was completed on 27 September 2012. Seining began at the uppermost sub-reach near river-mile 319 (Split Mountain boat ramp) and continued downstream by sampling three backwater habitats within every 5-mile sub-reach, concluding at river-mile 215 (Sand Wash). Due to low flows, not all 5-mile sub-reaches contained three backwaters. A total of 54 of 63 possible backwaters were sampled; 18 primary, 18 secondary, and 18 tertiary. Flow conditions impeded us from sampling nine backwaters in three sub-reaches, due to lack of backwater habitats meeting designated criteria. It was observed that backwater habitats were reduced in area and depth likely due to decreased base flows (Figure 1).

Green River main channel temperatures ranged from 15.5–21.1 °C, and backwater temperatures ranged from 14.9–27.6 °C during the sampling period. Discharge ranged from 1,240–1,280 cubic feet per second (cfs) during the sampling period, which is much lower than mean daily values (1,700–2,000 cfs) based on the period of record for this gauge (Figure 1). Flow conditions reduced the presence of backwater habitats and likely reduced the number of quality backwaters in the middle Green River. Discharge (USGS gauge #09261000 near Jensen) peaked at 10,300 cfs on May 25 and decreased to 1,700 cfs by June 24, which is considerably lower than the mean annual discharge of approximately 9,000 cfs for this period (Figure 1). Discharge in 2012 was approximately half of 2009 and 2010 (2,089–2,570 cfs) flows when Colorado pikeminnow YOY were abundant in this reach. Although this is not causation to why Colorado pikeminnow captures were poor, the steady decline in flows likely impeded drift and limited habitat availability and quality (Figure 1).

We captured two YOY Colorado pikeminnow and did not collect any juvenile Colorado pikeminnow during sampling in 2012 (Table 1). This represents the second lowest catch

per unit effort (CPUE; 0.03 fish/100m²) since 1990 (Table 1). However, the average length of captured Colorado pikeminnow was 53.5mm, larger than the 10-year average (49.17 mm), 15-year average (46.87 mm), and 27-year average (45.03 mm). Additional YOY native species collected from primary backwaters included 11 flannemouth sucker, one bluehead sucker, and one roundtail chub (Table 2). Native species YOY collected in secondary and tertiary backwaters included 17 bluehead sucker, 20 flannemouth sucker, one speckled dace and one unknown native sucker (either bluehead or flannemouth). Although both YOY Colorado pikeminnow were caught in primary backwaters, the highest proportions of bluehead and flannemouth sucker were found in secondary backwaters (Figure 2). Flannemouth and bluehead sucker YOY abundance was lower than many prior years, suggesting that low flows may have been detrimental to these species, or the overall high growth rates allowed fish to move out of backwater habitats and into main channel habitats prior to the sampling period.

Seine samples continue to be dominated by small-bodied nonnative cyprinids including fathead minnow, red shiner, and sand shiner (Figure 3). We collected a total of seven nonnative species in the first seine haul of the primary backwaters (Table 3). Nonnative species collected included channel catfish ($n = 6$), smallmouth bass ($n = 1$), common carp ($n = 1$), fathead minnow ($n = 189$), red shiner ($n = 2379$), gizzard shad ($n = 22$), and sand shiner ($n = 583$) (Table 3). Additional species collected in secondary and tertiary backwaters included black crappie ($n = 4$), black bullhead ($n = 5$), green sunfish ($n = 35$), white sucker ($n = 10$), and white x flannemouth sucker ($n = 1$). Secondary and tertiary backwaters also included two YOY smallmouth bass, which is down from the 2011 total of 28. As in 2011, the evidence provided suggests that smallmouth bass occupy slow-velocity areas for initial development before moving into riverine habitats, prior to when we typically sample backwaters. This demonstrates that age-0 smallmouth bass utilize backwater habitats in high flow and drought conditions. Thus, we hypothesize that movement of YOY smallmouth bass out of backwater habitats was expedited due to low flow conditions in 2012, explaining a high abundance in our 2011 samples, and low occurrences during previous years.

Although low numbers of native YOY were captured, the average size of these individuals was much larger, to the point of age-0 fish, achieving age-1 size within a few months. Flannemouth sucker mean length was 70 mm with the largest measuring 110 mm. Bluehead suckers also displayed significant growth with a mean length of 69 mm. Larger overall size of native suckers suggests that they will have a greater chance of survival through their first winter. It is also important to note that one speckled dace was collected for the first time since 2009 in a tertiary backwater (Figure 2).

Task 2: Lower Green River: Reach 3

Annual monitoring for YOY Colorado pikeminnow in Reach 3 began on 6 September 2012 and was completed on 16 September 2012. Seining was conducted on the Green River from river mile 120 (Green River State Park) to river-mile 0 (confluence with the Colorado River). Lower than normal daily flows prevented sampling from occurring in one pass. Sampling on the lower Green River was split into 3 reaches: river mile 120–97

(Green River State Park to Ruby Ranch), river mile 97–52 (Ruby Ranch to Mineral Bottom), and river mile 52–0 (Mineral Bottom to the confluence with the Colorado River). Sampling within these reaches began at the uppermost sub-reach and continued downstream. Sampling was conducted at two backwater habitats within every 5-mile sub-reach, as available. A total of 36 of 48 possible backwaters were sampled in 22 of 24 sub-reaches in the lower Green River. The total area seined in Reach 3 in 2012 (4716 m²) was higher than the 27-year average (3609 m²; Table 4). Reach 3 water temperatures ranged from 19.5–25 °C in the main channel and 19–30.5 °C in backwaters.

Lower Green River flows (measured at USGS Gage #9315000 in Green River) fluctuated between 1,820 cfs and 1,160 cfs over the eleven days of sampling. These flows are lower than the mean daily values (2,750–2960 cfs) for this time of year based on the period since dam operation began (1964–2012) as well as below the mean daily values (2,680–2,980 cfs) for this time of year based on the period of record for this gauge (1894–2012). The lower Green River, measured at USGS Gage #9315000 in Green River, peaked this year on May 27 at 10,900 cfs (Figure 4). This is much lower than both the 48-year mean peak (since dam operation began in 1964) of 22,955 cfs and the historical mean peak based on the period of record for this gauge (1894–2012) of 28,292 cfs.

In the lower Green River, 293 YOY Colorado pikeminnow were captured, measured, and released. This includes six fish that measured 100–109 mm. Normally this would classify them as juvenile fish, but as they seem to be part of the same cohort of age-0 fish, for the purposes of this report they are considered young-of-year. The number of YOY pikeminnow found this year is higher than the 10-year average (220.8 fish/year) and 15-year average (239.2 fish/year), but lower than the 27-year average (475.4 fish/year; Table 4). CPUE this year was 6.21 fish/100m², which is consistent with the 10 and 15-year averages (6.92 fish/100m² and 6.66 fish/100m², respectively; Table 4) but lower than the 27-year average (14.05 fish/100m²; Table 4). The average length of YOY Colorado pikeminnow was 50.27 mm, which is larger than the 10, 15, and 27-year averages (42.46 mm, 39.86 mm, and 39.01 mm, respectively; Table 4). When calculated without the 6 pikeminnow measuring 100–109 mm, average total length was 49.15 mm, still larger than the 10, 15, and 27-year averages. This is consistent with the negative correlation found in the lower Green River between mean total length of fall YOY Colorado pikeminnow and the magnitude of spring peak flow (Breen et al. 2011).

Other natives species captured in the lower Green River included *Gila* spp. ($n = 2$), flannelmouth sucker ($n = 9$), and razorback sucker ($n = 2$) (Table 5). The mean total length of razorback sucker was 81 mm (80 mm and 82 mm). It should be noted that the general size of YOY natives are larger this year, consistent with findings reported in previous low-water years (Breen et al. 2011). This is the first time that YOY razorback sucker have been identified during this study. YOY Razorback sucker have, however, been found in this reach during summer monitoring under Project #160: Lower Green River Razorback Sucker Larval and Young-of-Year Monitoring Pilot Study. One early juvenile razorback sucker (28 mm) was found on 27 July 2009 (Badame 2009). In 2011, 17 razorback sucker (23–62 mm; mean total length of 38.41 mm) were found in this reach between 24 July 2011 and 10 August 2011 (Howard 2012).

Nonnative captures were only enumerated during the first seine haul in each primary habitat in the lower Green River. Total catches in Reach 3 included nine nonnative species and were dominated by small-bodied nonnative cyprinids. These included sand shiner ($n = 8,620$), fathead minnow ($n = 3,085$), red shiner ($n = 2,043$), gizzard shad ($n = 15$), black bullhead ($n = 8$), channel catfish ($n = 5$), common carp ($n = 5$), green sunfish ($n = 4$), and yellow bullhead ($n = 3$) (Table 6). It should be noted that more than twice as many gizzard shad were captured this year than in all other years of the study combined (Table 6).

Task 3: Lower Colorado River: Reach 1

Annual monitoring for YOY Colorado pikeminnow in Reach 1 began on 6 September 2012 and was completed on 16 September 2012. Seining on the Colorado River was conducted from river mile 110 (Cisco Landing) to river mile 0 (confluence with the Green River). Backwater habitats were sampled within every 5-mile sub-reach, as available. A total of 28 of 44 possible backwaters were sampled in 18 of 22 sub-reaches in the Colorado River. The total area seined in Reach 1 in 2012 (2240 m²) was slightly lower than the 26-year average (2,952 m²; Table 7). Reach 1 water temperatures ranged from 20–24 °C in the main channel and 18–26 °C in backwaters.

Colorado River flows (measured at USGS Gage #9180500 near Cisco) fluctuated between 2,860 cfs and 2,150 cfs over the eleven days of sampling. These flows are below the mean daily values (3,460–3,960 cfs) for this time of year based on the period of record for this gauge (1914–2012). The lower Colorado River, as measured at USGS Gage #9180500 near Cisco, peaked this year on April 3 at 5,960 cfs (Figure 5). This is much lower than the 50-year mean peak of 28,753 cfs and the historical mean peak based on the period of record for this gauge (1914–2012) of 34,861 cfs.

In the lower Colorado River, 54 YOY Colorado pikeminnow were captured and measured. All fish were sorted, identified and enumerated in the field. Fifty-three of the 54 fish were released alive; one died during the enumeration process and was released. The number of Colorado pikeminnow captured is slightly higher than the 10-year average (44.6 fish/year) but lower than the 15-year average (65.8 fish/year), and the 27-year average (127.8 fish/year) (Table 7). CPUE this year was 2.41 fish/100 m². This is slightly higher than the 10-year and 15-year average CPUE (2.10 fish/100 m² and 2.04 fish/100 m², respectively) but lower than the 27-year average CPUE (4.25 fish/100 m²) (Table 7). The mean total length of YOY Colorado pikeminnow in 2012 was 56.65 mm, which is longer than the 10-year average (38.97 mm), the 15-year average (39.73 mm), and the 27-year average (38.41 mm) (Table 7). This is also consistent with the negative correlation found in the lower Colorado River between mean total length of fall YOY Colorado pikeminnow and magnitude of spring peak flow (Breen et al. 2011).

Other natives species captured in the Colorado River included bluehead sucker ($n = 4$), flannelmouth sucker ($n = 39$), and razorback sucker ($n = 3$) (Table 8). This is also the first time that YOY razorback sucker have been found in this reach during this study.

The mean total length of the razorback sucker was 98.33 mm (80 mm, 107 mm, and 108 mm).

Eight nonnative species were captured in Reach 1 (Table 9). Nonnative captures were again only enumerated during the first seine haul in each primary habitat in the lower Colorado River. Nonnative fish captured included sand shiner ($n = 5,204$), fathead minnow ($n = 3,182$), red shiner ($n = 471$), gizzard shad ($n = 70$), black bullhead ($n = 36$), channel catfish ($n = 15$), common carp ($n = 14$), green sunfish ($n = 6$), Western mosquitofish ($n = 2$), and largemouth bass ($n = 2$) (Table 9). Of the nonnative cyprinids encountered, 1,990 were not identified to species. Based on the percentage of sand shiner (58.8%), fathead minnow (35.9%), and red shiner (5.3%) positively identified in this reach, these 1,990 unidentified cyprinids were applied proportionately to sand shiner ($n = 1,117$), fathead minnow ($n = 682$), and red shiner ($n = 101$).

Task 4: Data entry was completed by November 1, 2012 for all reaches and database management is ongoing.

Task 5: Data analysis and report writing is on track and the annual report will be provided by November 14, 2012.

VIII. Recommendations:

- Continue to monitor annual relative abundance of post-larval Colorado pikeminnow in the middle Green River, lower Green River and lower Colorado River to develop indices and determine the relationships between these indices and stream flow, water temperature, abundance of sympatric fishes, and physical characteristics of backwaters.
- Determine whether data collected through this project is feasible for evaluating YOY native fish response to nonnative predator control measures in the middle Green River. Prolonged high flows that likely disrupted the timing in smallmouth bass spawning activities and subsequent YOY development in combination with an abundance of smallmouth bass YOY collected in 2011, raises some interesting questions regarding habitat overlap and our ability to detect a response with this data. Based on the timing of ISMP and Native Fish Response sampling (late September), habitat overlap between YOY native fishes and early life-stages of nonnative predators in the middle Green River is likely a limiting factor (at time of sampling) in comparison to other reaches in the upper Colorado River basin where native fish response is being assessed (e.g., Yampa River; Bestgen et al. 2007). We suggest that a separate study specifically focused on investigating YOY native species overlap with YOY nonnative predators on a temporal scale is necessary to determine whether detrimental interactions are occurring when they are most crucial (i.e., while nonnative predators are utilizing the same habitats).
- The sampling protocol for ISMP targets backwater habitat where Colorado pikeminnow are commonly encountered. It has been suggested that the limited number of YOY razorback sucker found during fall ISMP sampling indicates either

limited survival from the larval stage or that they are utilizing different habitats (specifically flooded tributaries) than those backwaters sampled for YOY Colorado pikeminnow (Badame 2009). Pending identification results from Colorado State University Larval Fish Laboratory of samples collected under Project #160, determine if further study of YOY razorback sucker in the lower Green River and possibly lower Colorado River is needed. If needed, extend YOY razorback sampling under Project #160 into the fall to specifically target these fish.

- Temperature trends on the lower Green River and lower Colorado River cannot be examined because continuous and accurate temperature data is not available from current local gages. Determine if temperature is as directly correlated to YOY survival as flow or major climatic events. If it is concluded that temperature is an important factor to consider, devise method to collect more accurate temperature data.
- Develop a measure or scale to describe localized hydrologic/climatic events, specifically flash flood events. Although the magnitude and timing of peak flows have been found to be related to YOY abundance and growth, we do not have an adequate measure for more localized hydrologic/climatic events that can affect a significant percentage of the zero velocity habitats.

IX. Project Status:

On track and ongoing

X. FY 2012 Budget Status

- A. Funds Provided: \$53,659
- B. Funds Expended: \$53,659
- C. Difference: \$0
- D. Percent of the FY 2012 work completed: 100%
- E. Recovery Program funds spent for publication charges: \$0

XI. Status of Data Submission: Data is formatted and has been QA/QC checked and will be submitted to the USFWS by January 2013.

XII. Signed: Katie Creighton, Joseph A. Skorupski Jr. November 9, 2012
Investigator Date

XIII. Literature Cited

Badame, P. 2009. Lower Green River Razorback Sucker Larval and Young-of-Year Monitoring Pilot Study. Annual Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Breen, M.J., M. Swasey, P. Badame, K. Creighton. 2011. Upper Colorado River basin young-of-year Colorado pikeminnow (*Ptychocheilus lucius*) monitoring: Summary report 1986-2009. Final Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

Howard, J. 2012. Lower Green River Razorback Sucker Larval and Young-of-Year Monitoring Pilot Study. Annual Report of Utah Division of Wildlife Resources to Upper Colorado River Endangered Fish Recovery Program. Denver, CO.

USFWS. 1987. Interagency standardized monitoring protocol handbook. U.S. Fish and Wildlife Service. Grand Junction, CO.

Table 1. The middle Green River (Reach 4) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m²), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1990—2012. *To be consistent with previous years, information in this table contains only those individuals captured in the first two backwaters of a sub-reach.*

*Four YOY Colorado pikeminnow were not included because they were not measured.

Year	Colorado Pikeminnow Caught	Mean Length (mm)	Length Range (mm)	Total Area Sampled (m ²)	CPUE (Fish/100m ²)
1990	341	45.4	28 – 80	5093	5.5
1991	524	38.2	21 – 65	5077	10.3
1992	183	43.1	26 – 133	4697	3.9
1993	305	36.4	21 – 59	3960	7.7
1994	15	67.2	60 – 80	4356	0.3
1995	75	34.5	21 – 48	3792	2.0
1996	79	39.4	25 – 60	3912	2.0
1997	22	36.0	28 – 49	3734	0.6
1998	73	38.5	22 – 61	4986	0.9
1999	12	33.7	25 – 45	3897	0.3
2000	31	50.9	37 – 76	3798	0.8
2001	8	46.9	36 – 67	4496	0.2
2002	0	N/A	N/A	5202	0
2003	2	52	52 – 52	4696	0.04
2004	60	43.8	31 – 63	4686	1.28
2005	8	48.6	35 – 60	4190	0.2
2006	5	45.8	36 – 50	7490	0.07
2007	3	73.3	69 – 76	5782	0.05
2008	18	43.9	36 – 56	4994	0.36
2009	325	43.7	22 – 71	7503	4.3
*2010	454	37.9	24 – 58	-	-
2011	0	N/A	N/A	7852	0
2012	2	53.5	39-68	7805	0.03

Table 2. The middle Green River (Reach 4), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2012. Colorado pikeminnow abundance reflects captures from primary and secondary backwaters sampled in each sub-reach; abundance of other native species reflects captures from primary backwaters only. In some years, species other than Colorado pikeminnow were only enumerated during the first seine haul within primary backwaters. Species collected include YOY Colorado pikeminnow (CS YOY; 10 – 99 mm), juvenile pikeminnow (CS JUV; 100 – 399 mm), unidentified *Gila* spp. (CH), bonytail (BT), roundtail chub (RT), flannemouth sucker (FM), bluehead sucker (BH), and speckled dace (SD).

Year	CS YOY	CS JUV	CH	BT	RT	FM	BH	SD
1986	492	0	32	–	0	47*	47*	132
1987	209	10	19	–	0	67	277	2
1988	885	36	5	–	0	120	1	6
1989	62	0	41	–	0	16	80	3
1990	341	47	22	–	0	0	9	2
1991	524	0	7	–	0	0	0	0
1992	183	0	4	–	1	2	115	11
1993	305	0	40	–	0	54	80	7
1994	15	0	13	–	0	38	32	10
1995	75	0	6	–	0	20	62	33
1996	79	0	6	–	1	31	53	7
1997	22	0	42	–	0	12	73	8
1998**	73	0	63	–	0	25	49	6
1999	12	0	43	–	0	18	20	16
2000**	31	0	3	–	0	6	12	2
2001	8	0	23	–	0	78	0	0
2002	0	0	3	–	0	3	0	0
2003	2	0	2	–	0	4	2	0
2004	60	0	12	–	0	16	2	1
2005	8	2	13	–	0	7	3	2
2006	5	0	0	–	0	5	0	0
2007	3	1	2	–	0	10	11	0
2008	18	0	0	–	1	12	6	0
2009	325	0	0	–	13	57	36	1
2010	454	1	0	–	0	2	38	1
2011	0	3	0	–	1	57	35	0
2012	2	0	0	–	1	11	1	0

*Suckers not identified to species, thus half of suckers were applied to bluehead and half to flannemouth.

**One razorback sucker YOY was observed as well.

Table 3. Total abundance of nonnative fish collected during young-of-year monitoring in the middle Green River (Reach 4) from 1987 -2012. Only fish enumerated in primary backwater first seine hauls are included. Species collected include black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1987	0	0	0	1	3	873	0	8	0	0	0	0	9757	0	462	0	0	0
1988	2	0	0	7	2	620	0	13	0	0	0	0	4072	0	159	0	0	0
1989	0	0	0	7	43	865	0	22	0	0	0	0	4025	0	284	0	0	0
1990	0	0	0	1	4	1386	0	0	0	0	0	0	5395	0	87	0	0	0
1991	0	0	0	14	5	1	0	1	0	0	0	0	64	0	0	0	0	0
1992	1	0	0	3	15	1653	0	5	0	0	0	0	3178	0	440	0	0	0
1993	0	0	0	17	13	1512	0	3	0	0	0	0	4677	0	49	0	0	0
1994	0	1	0	0	0	2757	0	1	0	0	0	0	28,903	0	1890	0	0	0
1995	0	0	0	0	6	1304	0	1	0	0	0	0	3229	1	188	0	0	0
1996	0	0	0	0	5	486	0	8	0	0	0	0	2871	0	1265	0	0	0
1997	0	4	0	0	11	1067	0	3	0	0	0	0	1010	1	1152	0	3	0
1998	7	11	0	3	8	1569	0	17	0	0	1	0	2400	0	474	0	1	0
1999	3	3	0	0	23	407	0	68	0	0	0	0	1832	0	533	0	0	0
2000	2	3	0	0	12	1436	0	15	0	0	0	0	10,860	0	8072	0	0	0
2001	1	10	0	6	0	371	0	0	0	0	0	0	4512	0	283	0	0	0
2002	0	5	1	0	1	1303	0	39	0	0	0	0	11,516	0	1059	0	1	0
2003	0	1	0	0	48	89	0	0	0	0	0	0	3847	0	49	0	0	0
2004	0	1	0	4	1	337	0	8	0	0	0	0	5524	0	1207	0	5	0
2005	0	18	0	1	1	204	0	0	0	0	0	0	3654	0	552	0	0	0
2006	0	7	3	0	98	1431	0	1	5	0	0	0	19,365	0	2060	0	3	0
2007	9	0	0	10	16	327	0	0	3	0	0	0	5754	6	3940	0	13	0
2008	1	16	0	3	40	155	0	102	0	0	0	0	1121	5	821	0	7	0
2009	0	4	0	0	17	108	0	1	2	0	0	0	2101	1	417	0	5	0
2010	1	0	0	1	38	231	0	15	0	0	0	0	3596	0	959	0	8	0
2011	5	3	0	0	13	867	0	14	0	0	0	0	1682	2	301	0	0	0
2012	0	0	0	6	1	189	0	0	22	0	0	0	2379	1	583	0	0	0

Table 4. The lower Green River (Reach 3) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m²), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2012.

Reach 3	YOY Colorado	Mean Length	Length Range	Total Area	CPUE
Year	Pikeminnow	(mm)	(mm)	Sampled	(fish/100m²)
	Caught			(m²)	
1986	813	28.63		1964	41.40
1987	849	36.32		2831.8	29.98
1988	2892	39.41		3076.4	94.01
1989	1494	38.79		4261.8	35.06
1990	418	41.82		6516.6	6.41
1991	186	38.81		2822.2	6.59
1992	122	40.62		5181.6	2.35
1993	1616	37.36		4435.4	36.43
1994	354	37.36	14-74	3797.8	9.32
1995	56	49.98	23-99	2548	2.20
1996	410	24.94	13-45	2888.6	14.19
1997	39	41.4	19-75	2709.8	1.44
1998	252	33.1	19-40	3050.2	8.26
1999	384	32.1	18-68	4055.8	9.47
2000	705	26.8	15-38	5760	12.24
2001	17	37.9	21-88	5962	0.29
2002	22	43.2	30-68	4644.5	0.47
2003	124	64.9	22-90	4005.8	3.10
2004	80	60.1	30-96	1974	4.05
2005	63	46	26-84	2937.6	2.14
2006	331	31.2	23-41	4936	6.71
2007	686	40.3	23-80	3138	21.86
2008	60	44.8	26-95	2018	2.97
2009	423	35.32	20-46	2548	16.60
2010	131	29.86	15-45	2868	4.57
2011	17	22	15-26	1796	.95
2012	293	50.27	18-109	4716	6.21

Table 5. The lower Green River (Reach 3), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2012. Species listed are: YOY Colorado pikeminnow (CS YOY; 10-109 mm), juvenile pikeminnow (CS JUV; 110-399 mm), and unidentified *Gila* spp. (CH), bonytail (BT), humpback chub (HB), razorback sucker (RZ), flannelmouth sucker (FM), bluehead sucker (BH), and speckled dace (SD). In most years species other than CS were only enumerated during the first haul within primary backwaters.

Year	CS YOY	CS JUV	CH	BT	HB	RZ	FM	BH	SD
1986	813	0	15	0	0	0	0	0	24
1987	849	9	1	0	0	0	5	1	0
1988	2892	109	0	0	0	0	2	0	2
1989	1494	59	1	0	0	0	17	0	0
1990	418	21	0	0	0	0	0	0	7
1991	186	3	0	0	0	0	0	2	2
1992	122	12	18	0	0	0	3	7	4
1993	1616	2	0	0	0	0	12	33	43
1994	354	0	7	0	1	0	0	1	6
1995	56	1	5	0	0	0	12	17	35
1996	410	1	0	0	0	0	1	21	20
1997	39	8	2	0	0	0	0	2	2
1998	252	0	0	0	0	0	0	3	30
1999	384	0	2	0	0	0	90	5	24
2000	705	3	1	0	0	0	0	0	5
2001	17	0	0	0	0	0	0	0	3
2002	22	0	1	0	0	0	4	0	4
2003	124	0	5	0	0	0	0	0	2
2004	80	0	0	0	0	0	1	1	0
2005	63	1	0	0	0	0	0	0	0
2006	331	0	6	0	0	0	0	0	0
2007	686	0	1	2	0	0	0	0	0
2008	60	1	0	0	0	0	8	0	1
2009	423	0	1	0	0	0	0	0	2
2010	131	3	0	0	0	0	7	3	12
2011	17	0	0	0	0	0	1	0	0
2012	293	0	2	0	0	2	9	0	0

Table 6. The lower Green River (Reach 3), total captures by year for nonnative fish during young-of-year monitoring from 1986-2012. Only fish enumerated in primary backwater first seine hauls are included to maintain consistency among years and reaches. Species listed: black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1986	7	0	0	4	12	87	0	9	0	0	0	0	663	0	4	0	0	0
1987	0	0	0	1	0	34	0	5	0	0	0	0	1,303	0	4	0	0	0
1988	1	0	0	110	2	1,790	7	1	0	0	0	0	4,317	0	38	0	0	0
1989	1	0	0	73	1	170	0	3	0	0	0	0	5,826	0	113	0	0	0
1990	1	0	0	37	4	228	0	0	0	0	0	0	9,599	0	129	0	0	0
1991	0	0	0	8	3	314	0	2	0	0	0	0	7,746	0	1,123	0	0	0
1992	1	0	0	24	1	500	0	0	0	0	0	0	2,737	0	180	0	0	0
1993	1	0	0	11	1	249	0	0	0	0	0	0	3,443	0	1,362	0	0	0
1994	0	0	0	6	8	500	1	8	0	0	0	0	8,007	0	1,196	0	0	0
1995	7	0	0	4	16	363	0	6	0	0	0	0	3,478	0	969	0	0	0
1996	0	0	0	0	0	1,097	2	2	0	0	0	0	11,858	0	3,751	0	0	0
1997	0	0	0	17	1	79	4	3	0	0	0	0	855	0	320	0	1	0
1998	0	6	0	0	1	120	17	0	0	0	0	0	1,709	0	178	0	0	0
1999	0	1	0	2	37	340	1	0	0	0	0	0	845	0	156	0	0	0
2000	3	0	0	12	3	234	0	1	0	0	0	0	3,591	0	574	0	4	0
2001	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	122	2	14,721	0	1	0	0	0	0	26,710	0	2,135	0	0	0
2003	5	0	0	11	1	201	0	12	0	0	0	0	4,707	0	43	0	0	0
2004	3	0	0	7	0	215	0	1	0	0	0	0	297	0	190	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	2	1	0	6	3	1,187	1	4	0	1	0	0	8,623	0	0	0	0	0
2007	0	0	0	23	0	2,183	0	0	1	2	0	0	8,807	0	35	0	0	0
2008	0	2	0	13	116	1,074	0	0	1	1	0	0	4,458	0	250	0	0	6
2009	0	0	0	3	0	1,044	0	0	1	0	0	0	2,766	0	15	0	0	0
2010	0	0	0	0	0	150	0	5	4	0	0	0	1,028	0	1,025	0	0	0
2011	0	8	0	6	15	314	0	0	0	0	0	0	1,842	0	1,096	0	0	0
2012	8	0	0	5	5	3,085	0	4	15	0	0	0	2,043	0	8,620	0	0	3

Table 7. The lower Colorado River (Reach 1) total numbers, lengths and mean catch-per-unit-effort (CPUE; fish/100m²), by year for YOY Colorado pikeminnow caught during young-of-year monitoring for the period of 1986—2012.

Reach 1	YOY Colorado Pikeminnow	Mean Length	Length Range	Total Area Sampled	CPUE
Year	Caught	(mm)	(mm)	(m²)	(fish/100m²)
1986	192	27.86	17-36	1343.6	14.29
1987	176	40.93		2225.8	7.91
1988	172	47.98		3786.8	4.54
1989	132	42.67		3739.2	3.53
1990	179	41.90		2565.8	6.98
1991	150	34.17		2271	6.61
1992	151	33.55		3663.2	4.12
1993	206	32.28	22-47	2858.8	7.21
1994	142	64.07	32-96	3139.8	4.52
1995	85	20.46	11-35	2890	2.94
1996	866	39.6	20-81	4113.8	21.05
1997	12	18.3	13-34	2774.8	0.43
1998	88	34.5	20-60	4663.8	1.89
1999	13	25	19-43	4710	0.28
2000	398	45.7	25-82	6389.6	6.23
2001	17	42.3	23-65	4046.8	0.42
2002	25	57.2	32-87	3033.8	0.82
2003	0	N/A	N/A	2837.8	0.00
2004	16	47	33-63	1620	0.99
2005	19	36.1	28-48	1722	1.10
2006	4	42	27-53	1682.4	0.24
2007	24	37.2	28-47	2802	0.86
2008	0	N/A	N/A	2568	0.00
2009	243	32.75	15-63	2193.4	9.46
2010	27	35.93	26-61	2630.4	1.03
2011	59	24.15	18-36	1195.2	4.94
2012	54	56.65	53-83	2240	2.41

Table 8. The lower Colorado River (Reach 1), total captures by year for native and endangered fish during young-of-year monitoring from 1986-2012. Species listed are: YOY Colorado pikeminnow (CS YOY; 10-99 mm), juvenile pikeminnow (CS JUV; 100-399 mm), unidentified *Gila* spp. (CH), bonytail (BT), humpback chub (HB), razorback sucker (RZ), flannelmouth sucker (FM), bluehead sucker (BH), and speckled dace (SD). In most years species other than CS were only enumerated during the first haul within primary backwaters.

Year	CS YOY	CS JUV	CH	BT	HB	RZ	FM	BH	SD
1986	192	0	194	0	0	0	0	0	41
1987	176	2	27	0	0	0	2	7	2
1988	172	37	11	0	0	0	4	0	0
1989	132	7	130	0	0	0	2	3	2
1990	179	11	6	0	0	0	4	2	0
1991	150	0	8	0	0	0	1	0	5
1992	151	1	45	0	0	0	2	25	9
1993	206	3	216	0	0	0	69	198	23
1994	142	0	15	0	0	0	0	11	1
1995	85	0	119	0	0	0	2	176	28
1996	866	0	30	0	0	0	3	87	29
1997	12	0	4	0	0	0	1	12	4
1998	88	0	11	0	0	0	1	8	9
1999	13	2	1	0	0	0	0	1	0
2000	398	9	21	0	0	0	1	58	0
2001	17	0	1	0	0	0	0	0	1
2002	25	0	35	0	0	0	0	1	0
2003	0	0	0	0	0	0	0	0	0
2004	16	0	4	0	0	0	9	5	0
2005	19	0	0	0	0	0	0	0	0
2006	4	0	0	0	0	0	9	1	3
2007	24	0	0	0	0	0	2	0	0
2008	0	0	0	0	0	0	4	8	0
2009	243	0	0	0	0	0	5	3	1
2010	27	3	2	0	0	0	15	0	0
2011	59	0	3	0	0	0	31	0	2
2012	54	0	0	0	0	3	39	4	0

Table 9. The lower Colorado River (Reach 1), total captures by year for nonnative fish during young-of-year monitoring from 1986-2012. Only fish enumerated in primary backwater first seine hauls are included to maintain consistency among years and reaches. Species listed: black bullhead (BB), black crappie (BC), bluegill (BG), channel catfish (CC), common carp (CP), fathead minnow (FH), gambusia (GA), green sunfish (GS), gizzard shad (GZ), largemouth bass (LG), northern pike (NP), plains killifish (PK), red shiner (RS), smallmouth bass (SM), sand shiner (SS), walleye (WE), white sucker (WS), and yellow bullhead (YB).

YEAR	BB	BC	BG	CC	CP	FH	GA	GS	GZ	LG	NP	PK	RS	SM	SS	WE	WS	YB
1986	0	0	0	4	0	456	2	0	0	1	0	6	1,077	0	240	0	0	0
1987	1	0	0	10	1	233	1	0	0	0	0	0	2,159	0	428	0	0	0
1988	0	0	0	0	4	10,650	0	1	0	0	0	36	1,786	0	2,161	0	0	0
1989	11	0	0	8	12	3,613	0	2	0	0	0	9	6,973	0	951	0	1	0
1990	2	0	2	11	4	5,698	1	1	0	1	0	10	6,593	0	889	0	0	0
1991	1	0	0	8	1	2,632	0	0	0	0	0	6	4,368	0	1,652	0	1	0
1992	1	0	0	0	1	2,809	2	7	0	0	0	7	6,470	0	3,991	0	1	0
1993	3	0	0	1	8	2,091	4	1	0	0	0	0	3,870	0	1,449	0	2	0
1994	1	0	0	1	2	4,795	14	34	0	0	0	0	4,393	0	2,520	0	2	0
1995	2	0	0	17	3	1,105	71	2	0	1	0	0	1,079	0	926	0	0	0
1996	0	0	2	1	0	2,591	3	15	0	1	0	8	3,851	0	5,998	0	0	0
1997	0	0	0	12	2	37	3	0	0	2	0	0	1,244	0	224	0	0	0
1998	0	0	0	1	0	265	1	6	0	0	0	2	6,297	0	8,751	0	0	0
1999	0	1	1	21	3	137	1	1	0	0	0	2	1,891	0	2,303	0	0	0
2000	4	0	0	0	1	1,265	24	2	0	1	0	0	15,099	0	22,343	0	1	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	1	0	0	4	3	4,963	1	0	0	0	0	1	11,691	0	2,920	0	0	0
2003	2	0	0	0	1	2,192	4	0	0	0	0	7	788	0	1,162	0	0	0
2004	0	0	0	0	1	352	0	0	0	0	0	0	625	0	535	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	1	2	0	4	1	159	94	10	0	2	0	1	3,030	0	103	0	0	1
2007	1	0	0	1	5	597	52	0	15	0	0	0	1,063	1	0	0	6	0
2008	0	0	0	1	5	280	1	0	17	1	0	0	536	0	5	0	1	1
2009	3	7	0	0	6	260	36	0	57	0	0	0	3,124	0	12	0	0	0
2010	0	0	0	2	0	377	3	0	174	5	0	0	657	0	622	1	0	0
2011	0	6	0	0	2	24	12	0	20	3	0	0	1345	0	58	0	0	0
2012	36	0	0	15	14	3,182*	2	6	70	2	0	0	471*	0	5,204*	0	0	0

*1,990 nonnative cyprinids were not identified to species. Based on the percentage of sand shiner (58.8%), fathead minnow (35.9%), and red shiner (5.3%) positively identified in this reach, these fish were applied proportionately to sand shiner ($n = 1,117$), fathead minnow ($n = 682$), and red shiner ($n = 101$).



USGS 09261000 GREEN RIVER NEAR JENSEN, UT

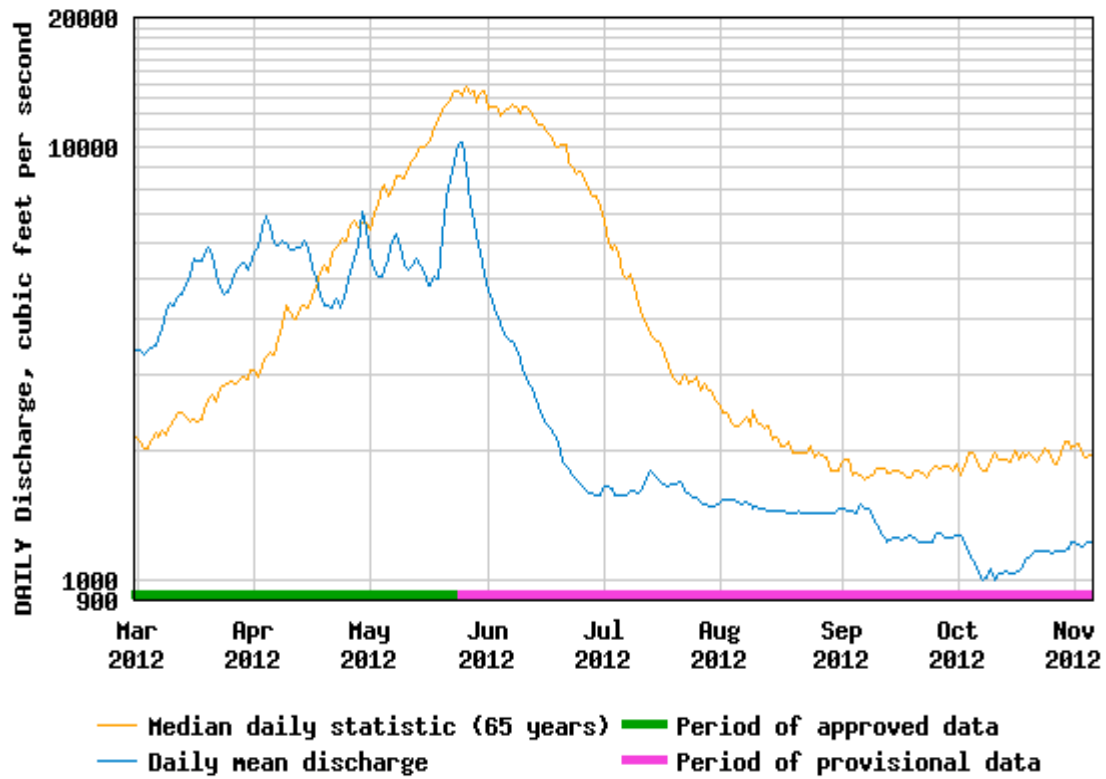


Figure 1. The Middle Green River (Reach 4) daily mean flows measured from the USGS gage at Jensen, Utah.

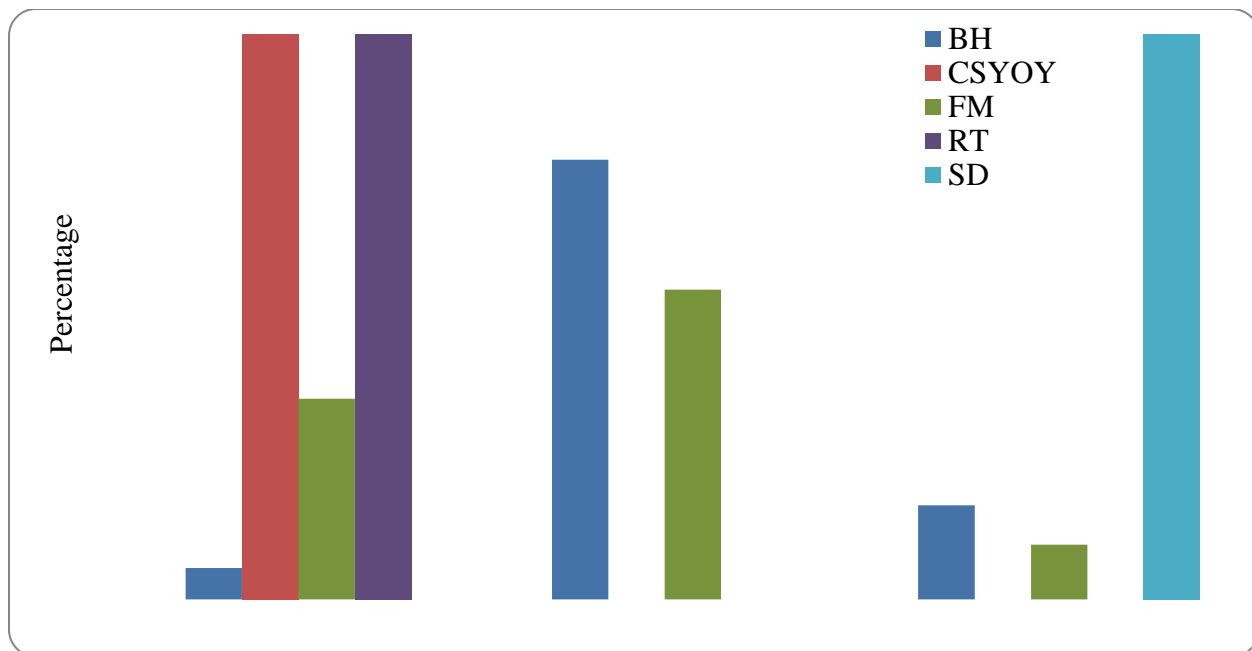


Figure 2. Proportional abundance (percent of species for all backwaters sampled in the middle Green River) of native species in primary, secondary and tertiary backwaters. Species include bluehead sucker (BH), YOY pikeminnow (CSYOY), roundtail chub (RT), flannemouth sucker (FM) and speckled dace (SD).

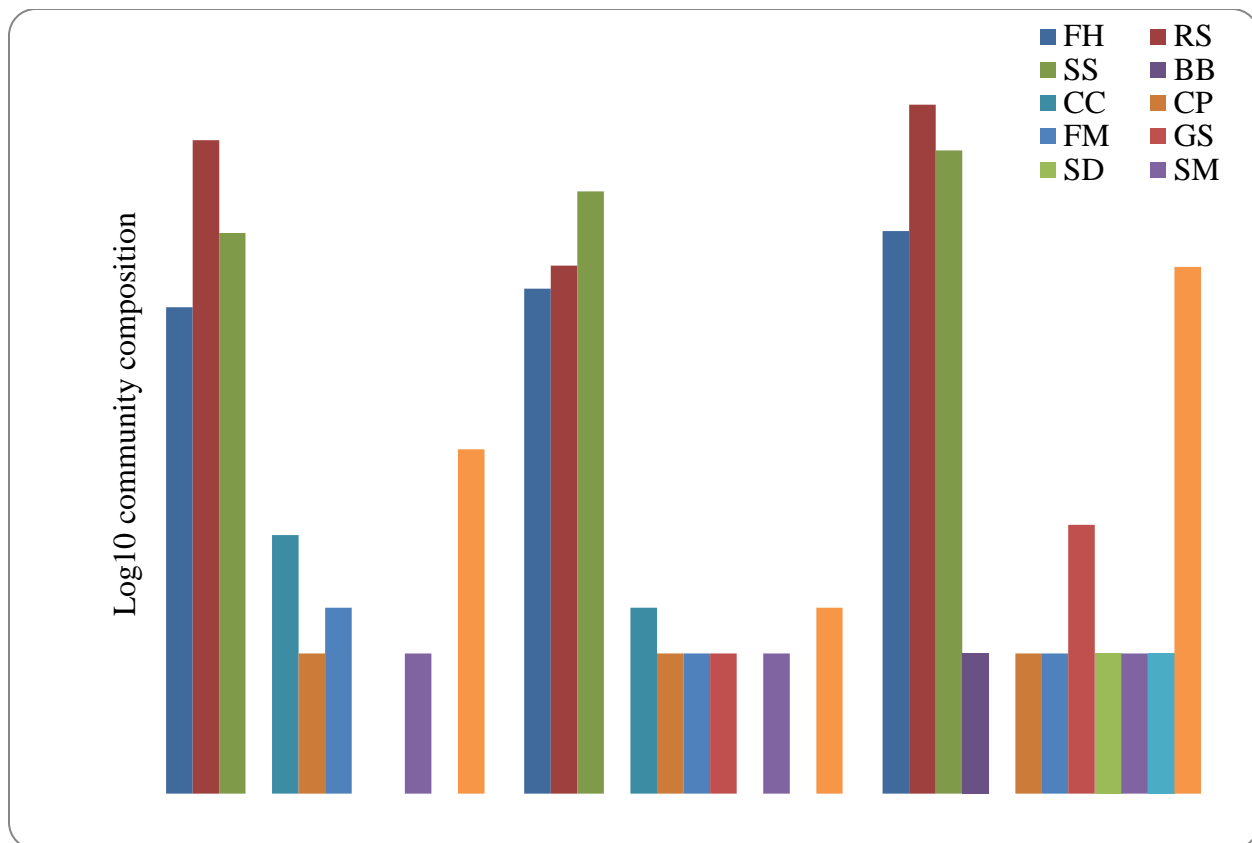


Figure 3. Community composition (percent of total for all backwaters sampled in the middle Green River) of primary, secondary and tertiary backwaters including native and nonnative fishes in a logarithmic scale. Species include bluehead sucker (BH), YOY pikeminnow (CSYOY), roundtail chub (RT), flannemouth sucker (FM), unknown suckers (bluehead or flannemouth; SU), speckled dace (SD), black bullhead (BB), channel catfish (CC), common carp (CP), fathead minnow (FH), green sunfish (GS), red shiner (RS), smallmouth bass (SM), sand shiner (SS), and gizzard shad (GZ).



USGS 09315000 GREEN RIVER AT GREEN RIVER, UT

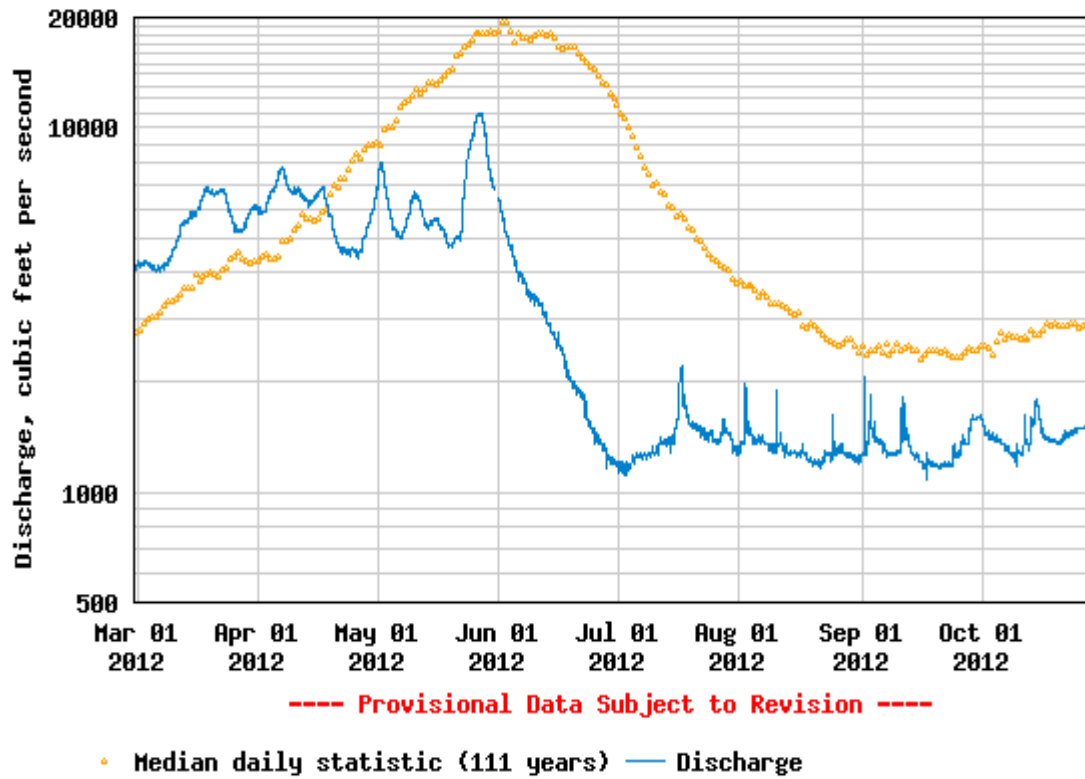


Figure 4. The lower Green River (Reach 3) daily mean flows measured from USGS Gage #09315000 at Green River, Utah from March 1, 2012 to October 29, 2012.



USGS 09180500 COLORADO RIVER NEAR CISCO, UT

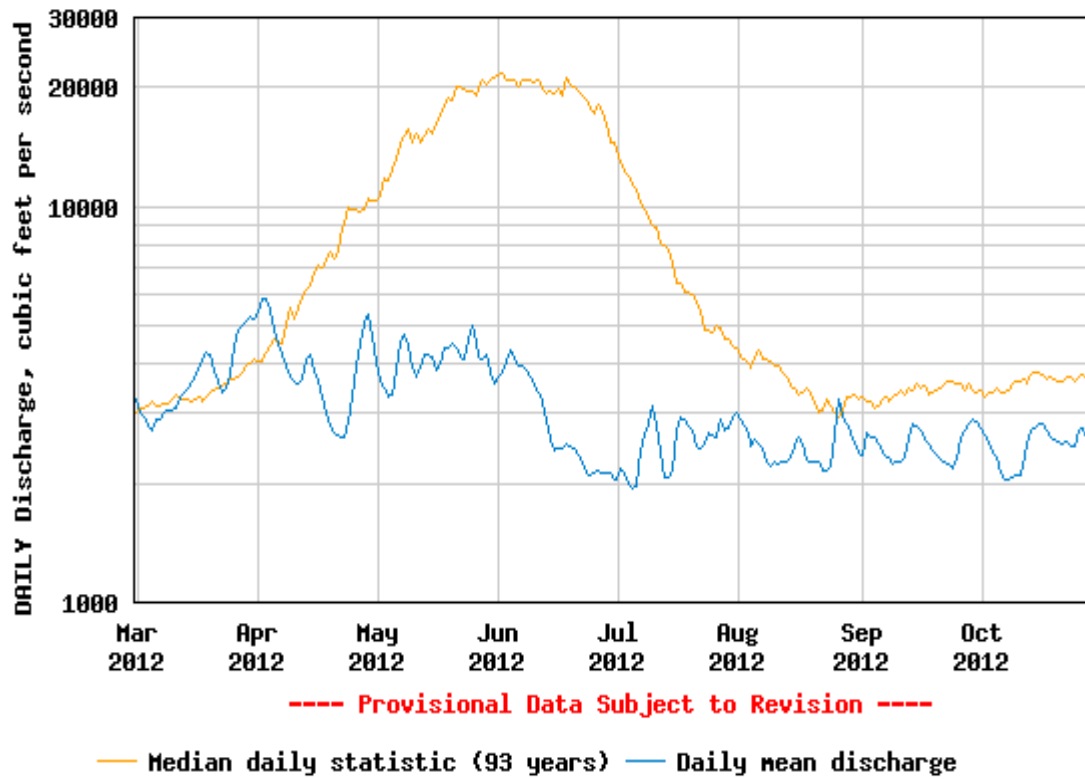


Figure 5. The lower Colorado River (Reach 1) daily mean flows measured from USGS Gage #09180500 near Cisco, Utah from March 1, 2012 to October 29, 2012.